Claims

1. A vertical-cavity device comprising:
(a) a chip comprising an active semiconductor layer for providing optical gain;
(b) a first mirror arranged on a first side of the active layer;
(c) a second mirror arranged on a second side of the active layer, opposite to the first mirror, and forming with at least the first mirror an optically resonant cavity that passes through the active layer in a direction out of the plane of the active layer;
(d) a heatspreader for removing heat from the active layer, the heatspreader being arranged inside the cavity and having a first surface adjacent to the chip and a second surface opposite to the first surface, the heatspreader being transparent to light of wavelengths in an operating bandwidth of the device;
characterised in that, in addition to removing heat from the active layer, the heatspreader also has one or more further selected property that has a further selected effect on light output from the device.

2. A device as claimed in claim 1, in which the heatspreader is birefringent and the further selected effect is on the polarisation of the output light.

3. A device as claimed in claim 2, in which the difference Δn between the refractive indices of the heatspreader's slow and fast polarisation axes is greater than 0.01.

4. A device as claimed in claim 2 or claim 3, comprising a further element that limits the output light to a linear polarisation.

5. A device as claimed in any of claims 1 to 4, in which the heatspreader has a nonlinear optical response.

6. A device as claimed in any preceding claim, in which the shape of the heatspreader provides the further selected effect.

7. A device as claimed in claim 6, in which the second surface of the heatspreader is curved or includes a curved structure.

8. A device as claimed in any preceding claim, in which the heatspreader focuses or defocuses the output light.

9. A device as claimed in any preceding claim, in which the heatspreader focuses pump light into the active layer.

10. A device as claimed in any preceding claim, in which the further selected effect is on light generated in the active semiconductor layer at a fundamental frequency of the device.

11. A device as claimed in any preceding claim, in which the selected property of the heatspreader has been selected to affect the spectrum of the output light.

12. A device as claimed in claim 11, in which the heatspreader has a refractive index that has been selected to provide substantially no refractive index step at the first surface.

13. A device as claimed in claim 12, in which reflectance at the first surface of the heatspreader is less than 5%.

14. A device as claimed in claim 10, in which the heatspreader has a refractive index that has been selected to provide a refractive index step at the first surface.

15. A device as claimed in any preceding claim, in which the second surface of the heatspreader is at an angle to the layers of the chip.

16. A device as claimed in any preceding claim, in which the heatspreader has a shape selected to provide control of a spatial mode of the output light.

17. A device as claimed in claim 16, in which the heatspreader focuses or defocuses intracavity light.

18. A device as claimed in claim 17, in which the second mirror is flat.

19. A device as claimed in claim 18 in which the second mirror is a MEMS mirror.

20. A device as claimed in any preceding claim, in which the second surface of the heatspreader has a dielectric coating.

21. A device as claimed in claim 20, in which the dielectric coating is an anti-reflection coating.

22. A device as claimed in claim 20, in which the dielectric coating is a mirror coating and it forms the second mirror.

23. A device as claimed in any preceding claim in which the heatspreader has a thickness of less than 1.5 mm.

24. A device as claimed in any preceding claim, in which the heatspreader is also a loss modulator.

25. A method of manufacturing a vertical-cavity device, comprising:

(a) fabricating a chip comprising an active semiconductor layer for providing optical gain;

(b) providing a first mirror on a first side of the active layer;

(c) providing a second mirror on a second side of the active layer, opposite to the first mirror, which forms with at least the first mirror an optically resonant cavity that passes through the active layer in a direction out of the plane of the active layer;

(d) providing in the cavity a heatspreader for removing heat from the active layer, the heatspreader having a

first surface adjacent to the chip and a second surface opposite to the first surface, the heatspreader being transparent to light of wavelengths in the operating bandwidth of the device;

characterised in that the method also includes the step of selecting one or more property of the heatspreader to have a selected effect on the output light, in addition to the effects of removing heat from the active layer.

26. A method as claimed in claim 25, including the step of forming the second surface of the heatspreader to be curved or to include a curved structure.

27. A method as claimed in claim 26, in which the curved surface is formed by polishing.

28. A method as claimed in claim 26, in which the curved surface or the curved structure is formed by etching.

29. A device manufactured by a method according to any of claims 25 to 28.

30. An amplifier or laser including a source of pump light comprising a device according to any of claims 1 to 24.

31. An amplifier or laser as claimed in claim 30 that is a Raman amplifier.

32. A vertical cavity device comprising:

(a) a chip comprising an active semiconductor layer for providing optical gain;

(b) a first mirror arranged on a first side of the active layer suitable for forming with at least a second mirror arranged on a second side of the active layer, opposite to the first mirror, an optically resonant cavity that passes through the active layer in a direction out of the plane of the active layer; and

(c) a heatspreader for removing heat from the active layer, having a first surface adjacent to the active layer and a second surface opposite to the first surface,

the heatspreader being transparent to light of wavelengths in an operating bandwidth of the device;

characterised in that, in addition to removing heat from the active layer, the heatspreader also has one or more further selected property that has a further selected effect on light output from the device.